IB Math HL Y1
Tuition Modeling Mini-Project

Name _____ Date _____

This project is due on Wednesday, September 24, and is worth 20 points. It must be submitted to turnitin.com by 8 am, and an (identical) hard copy is due at the start of class the same day.

The turnitin info is:

- Class name: IB Math HL Y1
- Class ID: 2410034
- Enrollment password: mathprojects

The project is an expanded version of a problem that appeared on one of your handouts from earlier in the year.

The chart on the right shows the average cost of tuition and fees (in USD) for a full-time student at a ***public*** college in the US.
Source: The College Board and National Center for Educational Studies

Academic Year	Tuition & Fees
1995-96	2811
1996-97	2975
1997-98	3111
1998-99	3247
1999-00	3362
2000-01	3487
2001-02	3725
2002-03	4115
2003-04	4694

1. Use technology (TI-Interactive, Excel, or other) to make a scatterplot of the data.

2. Find 3 different models for this data – a linear model, a quadratic model, and an exponential model. Show each of the models on a graph with the data.

3. Which model seems best? Why?

4. Use your chosen model to predict the average cost of tuition and fees for the year you will start college. What about 2018 and 2023, the years when Mr. Chao's two daughters are expected to start college?

5. Comment on different aspects of the mathematical modeling process, as exemplified by this example.

The rubric for this project is copied on the back of the sheet.

Other hints for successful math projects:

- Even though the assignment lists 5 separate questions, your write-up should read as a single, self-contained piece of mathematical writing, NOT a list of 5 separate answers. A mathematically knowledgeable reader should be able to pick up your paper and understand what you are trying to say, even without looking at the assignment sheet.
- Your thought process and mathematical reasoning should come through clearly.
- The language of a math project is somewhat more formal than that used in class. For example, say "substitute" instead of "plug in." Be careful to use correct mathematical notation and terminology. If you are not sure, check!
- Make sure graphs, diagrams and/or charts are labeled.
- Don't wait until the last minute!!

Tuition Modeling Mini-Project

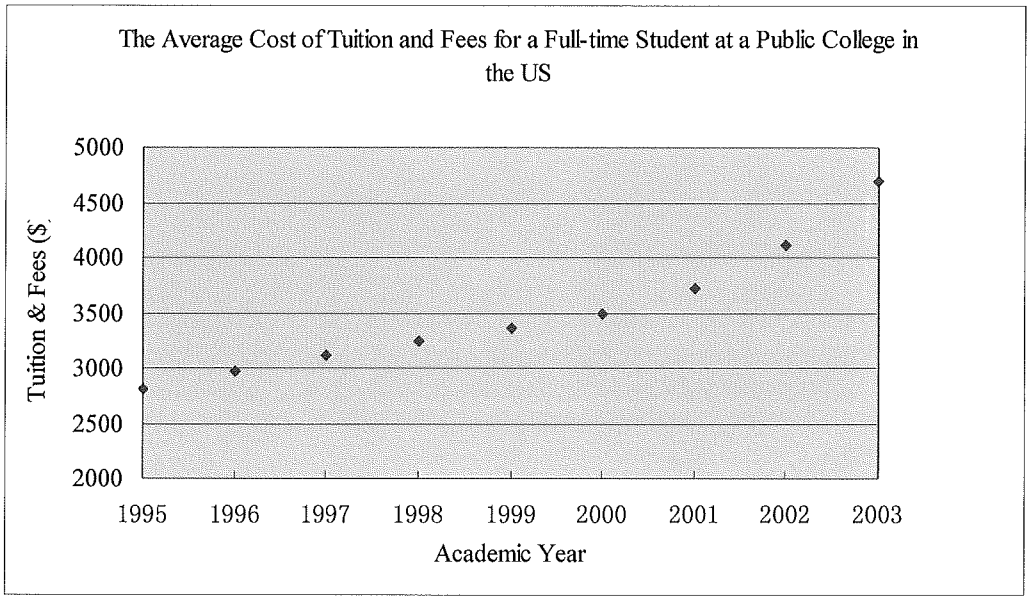
Note: The academic year that is listed in this project is only referring to the year in which the school year begins. So if chart were to show that in the year 1995 the tuition and fees is $2811, it should be inferred that the tuition and fees was $2811 in school year 1995-96.

In this investigation, I am given the statistics of the average cost of tuition and fees (in USD) for full-time student at a public college in the US over the years 1995 to 2003 (shown below and in Appendix, Table 1.1 and Graph 1.1). After calculating three different models for the data, I am to chose the best out of the three and use it to predict the tuition for years 2007, 2010, 2018, and 2023.

The Original Data:

Academic Year (x)	Tuition & Fees in Dollars (y)
1995	2811
1996	2975
1997	3111
1998	3247
1999	3362
2000	3487
2001	3725
2002	4115
2003	4694

Scatter Plot for the Original Data:



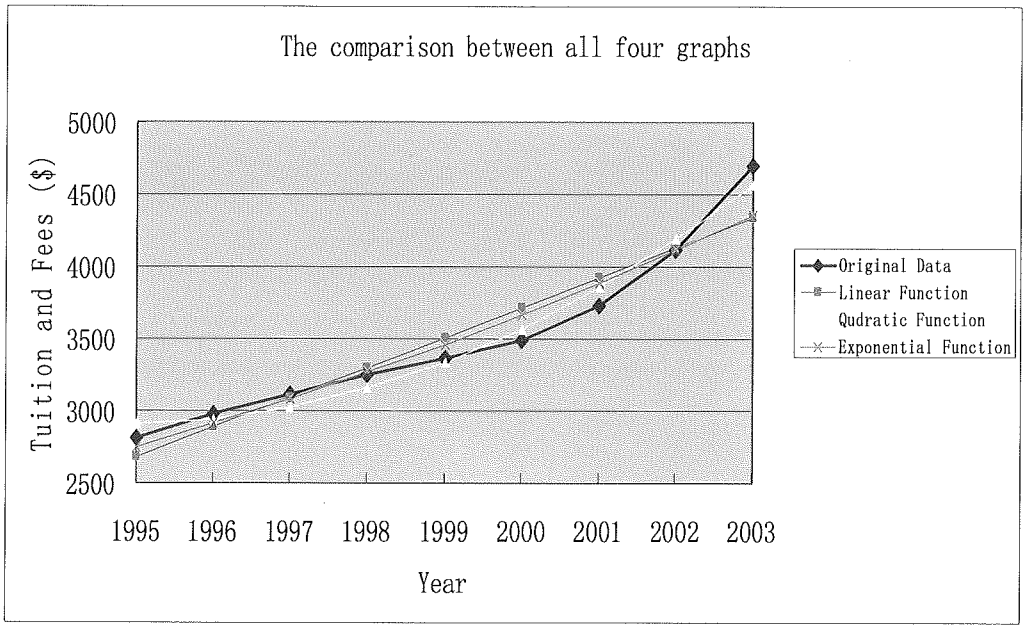
Using the calculator, I found that the *linear model* for the data provided is: f(x)=207(x-1994)+2468; x being the year, and f(x) being the average cost of tuition and fees. The table of data and graph that illustrates the average cost for public colleges in years 1995 through 2003 using the linear function

were then created using excel (See: Appendix Table 1.2 and Graph 1.2).

Using the calculator once more, I've found that the *quadratic model* for the given data to be approximately f(x)=25.28571429(x-1994)^2+(-45.85714286)(x-1994)+2931.571429; x being the year, f(x) being the average cost of tuition and fees. The table of data and graph that illustrates the average cost for public colleges in years 1995 through 2003 using the quadratic function were then created using excel (See: Appendix Table 1.3 and Graph 1.3).

I've also found, using the calculator, that the exponential function for the given data to be: f(x)=2594.988644*(1.059286236)^(x-1994); x being the year, f(x) being the average cost of tuition and fees. The table of data and graph that illustrates the average cost for public colleges in years 1995 through 2003 using the exponential function were then created using excel (Please check appendix Table 1.4 and Graph 1.4).

Without flipping back to the appendix we can conclude that the quadratic function seems to be the best model for the data given by examining the graph below:



On the other hand, we can also prove that the quadratic function is the best model for calculating the average cost of tuition and fees for a full-time student at public college in the US by checking each of the functions' coefficient correlation (using the calculator).

Linear function: .9054

Quadratic function: .9748

Exponential function: .9445

Correlation coefficient = r

r^2 = coefficient of determination

The closer the coefficient correlation is to +1, the stronger the positive correlation shown between that function and the original data. Quadratic function had the coefficient correlation to 1.

?

Using the best function available, I predicted the average cost of tuition and fees for the years 2007, 2010, 2018 and 2023:

Quadratic Function: f(x)=25.28571429(x-1994)^2+(-45.85714286)(x-1994)+2931.571429
f(2010)=8671 ->$8,8671
f(2018)=16395.57 ->$16,395.57
f(2023)=22867 ->$22,867
f(2007)=6608.714 ->$6, 608.71

According to CollegeBoard.com, the average cost for attending a four-year public college in the year 2007 is $6,185, which is very close to the predicted $6,608.71 for that year's tuition using the quadratic function. (For the same year, the exponential function predicted the cost to be $5,486.67, while the linear function predicted it to be $5,159.) Though the prediction is off by approximately $500, I still find the result as very surprising. I did not imagine that the change of our economy, or more specifically the change of the price of an average 4-year public college can be predicted by a mathematic function, because I had a mindset that evnets can be very spontaneous and random in the world (including our school tuition). However, the calculation has proved me somewhat wrong (I say "somewhat", because I still believe that the world can be very spontaneous.)

On the other hand, it is also important to take note that the time range this project is concerned with only spans within two decades. The economy of America had a steady growth over the past ten to fifteen years, which may explain why there is still a continuous positive trend in the average cost of a public college in the US. If a war, great depression, or a discovery of a technological advance that will take place of colleges were to occur within the next few years, however, the trend will break and the predictions for the average cost in years 2018 and 2023 shown above will be less accurate.

After comparing three different mathematic models to a set of data, and each of their predictions to what it came to be in reality, it is to my surprise to find that real life statistics are not as random as I expected. Knowing this, then, it is safe to assume that other mathematic models (such as square root, absolute value, rational, etc) also can be used to illustrate other trends that may be found in the world. (Despite the spontaneous nature life may have,) Through this investigation, we see that mathematic trend lines are trustworthy and are able to help us understand and predict the events that occur. Though facts and figures can seem to be interrelated and complicated, we can use mathematic models to find order in this chaos, and simplify the complex.

✓ Good

✓

✓

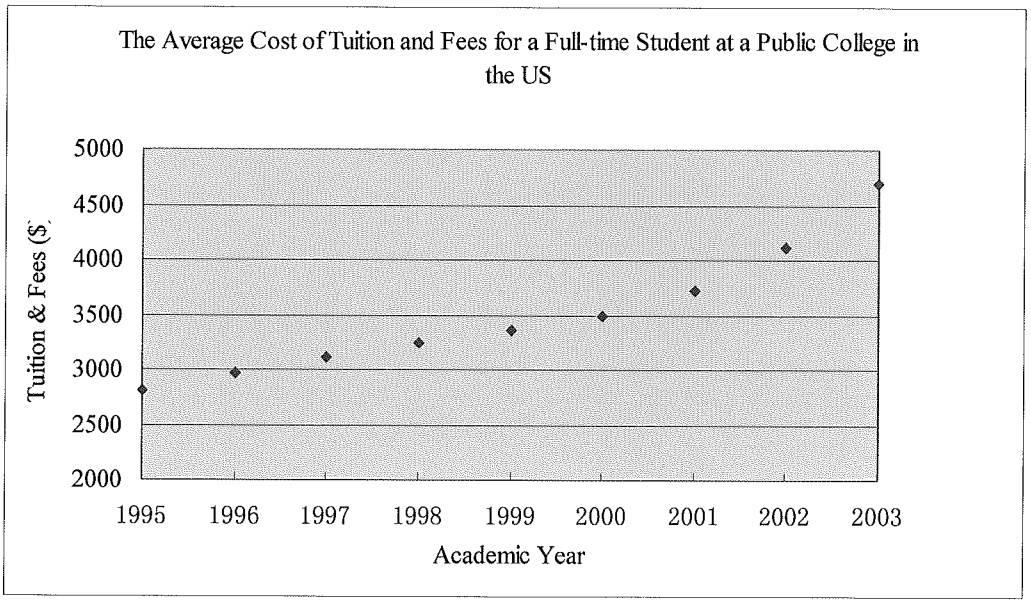
The results of applying a mathematical model can vary a lot, so I don't want you to overstate how well this works. Still, I'm glad you've had a chance to see this process in action.

APPENDIX

Original Data

Academic Year (x)	Tuition & Fees in Dollars (y)
1995	2811
1996	2975
1997	3111
1998	3247
1999	3362
2000	3487
2001	3725
2002	4115
2003	4694

Table 1.1



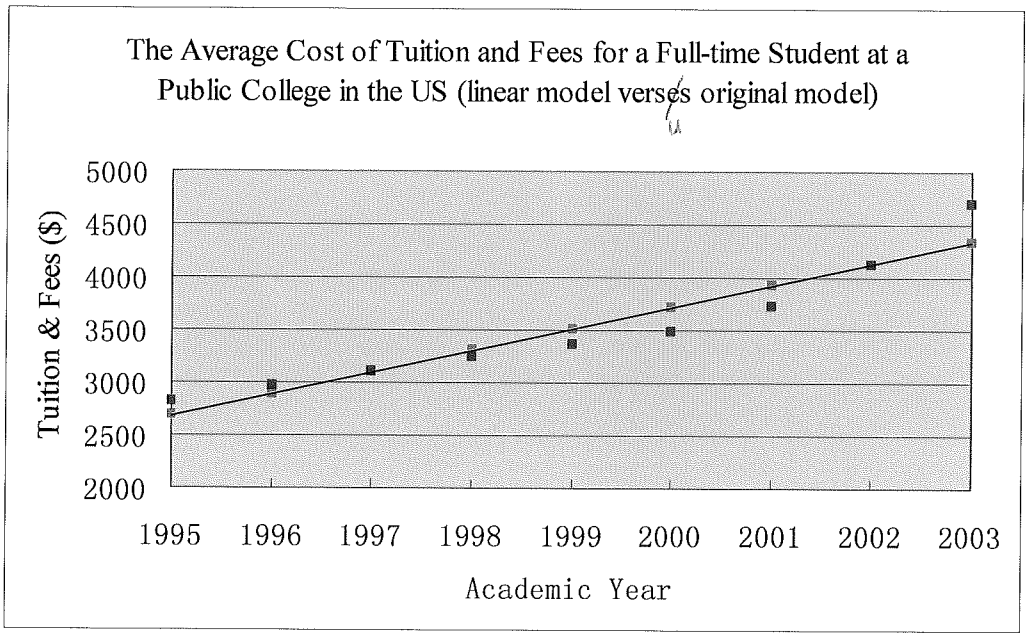
Graph 1.1

Linear Model

Academic Year (x)	Tuition and Fees in Dollars (y)
1995	2675
1996	2882
1997	3089
1998	3296
1999	3503
2000	3710
2001	3917
2002	4124
2003	4331

Would be nice to show the data here too original

Graph 1.2



Graph 1.2

Quadratic Model

Academic Year (x)	Tuition & Fees in Dollars (y)
1995	2911.00
1996	2941.00
1997	3021.57
1998	3152.71
1999	3334.43
2000	3566.71
2001	3849.57
2002	4183.00
2003	4567.00

Table 1.3

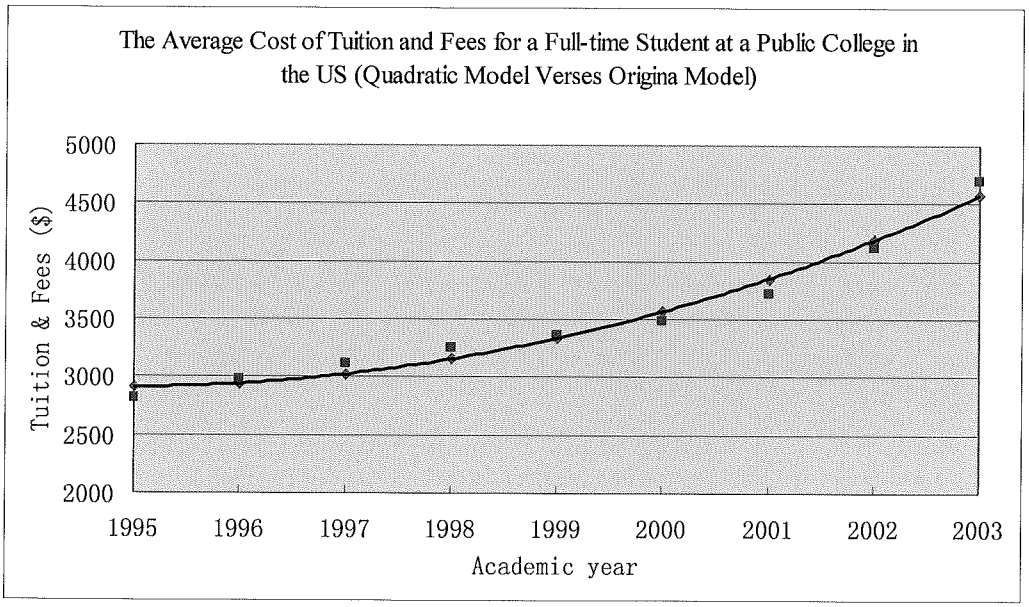
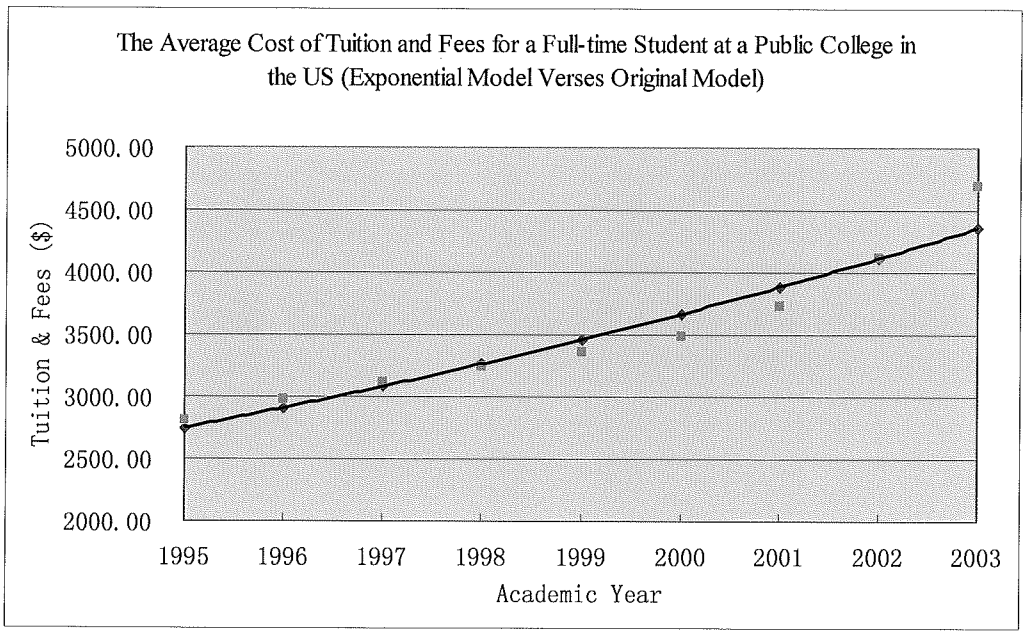


Table 1.3

Exponential Model

Academic Year (x)	Tuition & Fees in Dolloars (y)
1995	2748.84
1996	2911.80
1997	3084.43
1998	3267.30
1999	3461.00
2000	3666.19
2001	3883.55
2002	4113.79
2003	4357.68

Table 1.4



Graph 1.4